



US006248127B1

(12) **United States Patent**  
Shah et al.

(10) Patent No.: **US 6,248,127 B1**  
(45) Date of Patent: **Jun. 19, 2001**

(54) **THROMBORESISTANT COATED MEDICAL DEVICE**

(75) Inventors: Chirag B. Shah, Nashua, NH (US);  
Laurel L. Wolfgang, Townsend, MA (US)

(73) Assignee: Medtronic AVE, Inc., Santa Rosa, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/138,464

(22) Filed: Aug. 21, 1998

(51) Int. Cl.<sup>7</sup> ..... A61F 2/06

(52) U.S. Cl. .... 623/1.15; 427/2.1; 428/34.7;  
428/35.2; 428/35.7; 428/36.91; 428/425.6;  
428/425.8; 428/442; 428/447; 428/450;  
428/451; 428/458; 428/463; 428/480; 428/522

(58) Field of Search ..... 427/2.1; 428/34.6,  
428/34.7, 35.2, 35.7, 36.91, 423.1, 425.6,  
425.8, 442, 447, 450, 451, 458, 463, 480,  
522; 623/1.15

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,549,409	12/1970	Dyck	117/47
3,639,141	2/1972	Dyck	117/47 A
4,096,239	6/1978	Katz et al.	424/21
4,329,383	5/1982	Joh	428/36
4,373,009	2/1983	Winn	428/424.2
4,529,614	7/1985	Burns	427/2
4,604,412	8/1986	Joh et al.	523/112
4,632,842	12/1986	Karwoski et al.	427/2
4,678,660	7/1987	McGary et al.	424/25
4,718,907	1/1988	Karwoski et al.	623/12
4,720,512	1/1988	Hu et al.	523/112
4,836,646	6/1989	Parker et al.	350/96.34
4,979,959	12/1990	Guire	623/66
5,010,141	4/1991	Mueller	525/276
5,013,717	5/1991	Solomon et al.	514/56
5,026,607	6/1991	Kiezulas	428/423.7
5,053,048	10/1991	Pinchuk	623/1
5,077,372	12/1991	Hu et al.	528/70
5,081,031	1/1992	Tsilibary et al.	435/240.23
5,084,151	1/1992	Vallana et al.	204/192.11
5,084,315	1/1992	Karimi et al.	428/36.6
5,133,845	7/1992	Vallana et al.	204/192.15
5,134,192	7/1992	Feijen et al.	525/54.1
5,135,516	8/1992	Sahatjian et al.	604/265
5,160,790	11/1992	Elton	428/412
5,229,172	7/1993	Cahalan et al.	427/536
5,262,451	11/1993	Winters et al.	523/112
5,308,641	5/1994	Cahalan et al.	427/2
5,336,518	8/1994	Narayanan et al.	623/1
5,342,693	8/1994	Winters et al.	428/447

5,350,800	9/1994	Verhoeven et al.	525/54.2
5,356,433	10/1994	Rowland et al.	623/11
5,417,969	5/1995	Hsu et al.	424/78.27
5,441,759	8/1995	Crouther et al.	427/2.3
5,541,167	7/1996	Hsu et al.	514/56
5,543,019	8/1996	Lee et al.	204/192.15
5,558,900	9/1996	Fan et al.	427/2.28
5,576,072	11/1996	Hostettler et al.	427/532
5,607,475	3/1997	Cahalan et al.	623/11
5,609,629	3/1997	Fernot et al.	623/1
5,643,580	7/1997	Subramaniam	424/400
5,643,681	7/1997	Voorhees et al.	428/483
5,645,931	7/1997	Fan et al.	428/334
5,662,960	9/1997	Hostettler et al.	427/2.3
5,672,638	9/1997	Verhoeven et al.	523/112
5,679,659	10/1997	Verhoeven et al.	514/56
5,702,808	12/1997	Ljungberg et al.	428/216
5,767,108	6/1998	Cahalan et al.	514/56
5,804,318	9/1998	Pinchuk et al.	428/421
5,811,151	9/1998	Hendriks et al.	427/2.24
5,877,263	3/1999	Patnaik et al.	525/453
5,928,279	7/1999	Shannon et al.	623/1
5,955,588	9/1999	Tsang et al.	536/21

**FOREIGN PATENT DOCUMENTS**

0 338 418 A1	10/1989	(EP)
0 350 161 A2	1/1990	(EP)
0 351 314 B1	1/1990	(EP)
0 357 242 B1	3/1990	(EP)
0 379 156 B1	7/1990	(EP)
0 407 390 B1	1/1991	(EP)
0 517 890 B1	12/1992	(EP)
0 592 870 A1	4/1994	(EP)
0 595 805 B1	5/1994	(EP)
0 747 069 A2	12/1996	(EP)
0 809 999 A2	12/1997	(EP)
0 832 655 A2	4/1998	(EP)
0 861 858 A2	9/1998	(EP)
WO 98/02197		
A1	1/1998	(WO)
WO 98/08551	3/1998	(WO)
WO 98/08553	3/1998	(WO)

\* cited by examiner

Primary Examiner—D. S. Nakarani

(74) Attorney, Agent, or Firm—Sterne, Kessler, Goldstein & Fox P.L.L.C.

(57) **ABSTRACT**

Coatings are provided in which biopolymers may be covalently linked to a substrate. Such biopolymers include those that impart thromboresistance and/or biocompatibility to the substrate, which may be a medical device. Coatings disclosed herein include those that permit coating of a medical device in a single layer, including coatings that permit applying the single layer without a primer. Suitable biopolymers include heparin complexes, and linkage may be provided by a silane having isocyanate functionality.

**13 Claims, No Drawings**